REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

As a preliminary matter, Applicant notes with appreciation the following actions taken by the Examiner: approval of the drawings filed on October 24, 2005, acknowledgement of Applicant's claim for foreign priority under 35 U.S.C. § 119(a)-(d), receipt of all certified copies of the priority documents and consideration of the prior art references identified in the Information Disclosure Statement also filed on October 24, 2005.

Claims 25-49 stand rejected under 35 U.S.C. § 112, ¶ 1, as failing to comply with the enablement requirement. Applicant respectfully traverses the rejection of these claims as discussed in greater detail below. No prior art rejections to the claims have been made in the Office Action.

By this amendment, the specification has been amended to correct a minor informality. Support for the amendment to the specification can be at least found on page 11, lines 12 and 13 and Figure 4, step S3 of the present specification.

A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier. Claims 25-49 remain unchanged and are presently pending in this application for consideration.

THE CLAIMS COMPLY WITH THE ENABLEMENT REQUIREMENT

Claims 25-49 are rejected under 35 U.S.C. § 112, ¶ 1, for alleged lack of enablement. *See* Office Action, pages 2-4. According to the Office Action, "[t]he claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention." Office Action at pages 2 and 3. Applicant respectfully traverses this ground of rejection and respectfully submits that the specification provides sufficient guidance to allow one of skill in the art to practice the claimed invention.

The enablement requirement requires the specification to describe the invention "in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it

pertains, or with which it is most nearly connected, to make and use the same." 35 U.S.C. § 112 (2006). As explained in MPEP § 2164.01, "even though the statute does not use the term 'undue experimentation,' it has been interpreted to require that the claimed invention be enabled so that any person skilled in the art can make and use the invention without undue experimentation." MPEP § 2164.01 (citing *In re Wands*, 858 F.2d at 737, 8 U.S.P.Q.2d at 1404 (Fed. Cir. 1988)). "The test of enablement is not whether any experimentation is necessary, but whether, if experimentation is necessary, it is undue." MPEP § 2164.01 (citing *In re Angstadt*, 537 F.2d 498, 504, 190 U.S.P.Q. 214, 219 (CCPA 1976). That determination is made from the viewpoint of persons experienced in the field of the invention, *Elan Pharm., Inc. v. Mayo Found.*, 346 F.3d 1051, 68 U.S.P.Q.2d 1373 (Fed. Cir. 2003), and "requires the application of a standard of reasonableness, having due regard for the nature of the invention and the state of the art." *In re Wands*, 858 F.2d 731, 737, 8 U.S.P.Q.2d 1400 (Fed. Cir. 1988).

The undue experimentation inquiry invokes several factors, including, but not limited to: (1) the nature of the invention; (2) the state of the prior art and the level of predictability; (3) the amount of direction provided by the inventor; (4) the breadth of the claims; and (5) the quantity of experimentation needed to make or use the invention based on the content of the disclosure. *In re Wands,* 858 F.2d 731, 737, 8 U.S.P.Q.2d 1400 (Fed. Cir. 1988); MPEP § 2164.01(a).

As demonstrated below, applying these factors to the present case leads to the conclusion that the skilled artisan could have practiced the claimed invention without an undue amount of experimentation and, therefore, the enablement rejection of claims 25-49 is improper and should be withdrawn.

(1) The Nature of the Invention

The claimed invention is directed to an "anode effluent control method for a fuel cell power plant." Claim 25 specifies that the method comprises "calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed" and "calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened." Thus, claim 25 is directed to a

method that involves improving the power generation efficiency of a fuel cell power plant by setting the timing of an impurity gas removal operation appropriately. Claim 37, which is directed to an "anode efficient control device for a fuel cell", practices the method of claim 25 and includes the same patentable features and arrangements. Claim 49, which is also directed to an "anode efficient control device for a fuel cell" and practices the method of claim 25, includes the same patentable features and arrangements recited in means-plus-function language.

(2) State of the Prior Art and Predictability of the Art

The Office Action at page 3 states that using sensors to determine the hydrogen gas concentration, impurity gases concentration, temperature and pressure of the anode gas for removing impurity gases by purging the gas in the anode recirculation passage in accordance with a decrease in hydrogen concentration of the anode gas, an increase in the impurity gases concentration in the anode gas or a decrease in the output of the fuel cell system is well-known in the art. It can be reasonably concluded that it is also well-known in the art to use a controller which stores predetermined threshold values used to compare the detected value of the sensors with the stored threshold values as discussed in U.S. Patent No. 6,242,120, issued June 5, 2001.

(3) The Amount of Direction and Guidance Provided by the Inventor

The PTO alleges the following regarding the present specification:

(1) "[T]here is no explanation on how this map of EDH2n vs. PH2n is determined, nor are there any units for the generated energy EDH2n or hydrogen partial pressure PH2n."

(2) "[T]here is no explanation on what variables are measured, what mathematical formula or equation is used to calculate the generated energy EDH2n, the fuel cell operating conditions that were used to generate the map, or the hydrogen partial pressure PH2n shown in Figure 6."

(3) "[T]he specification also describes calculating a second energy loss by using a map having the characteristics shown in Figure 7 which defines the relationship between a variation in the hydrogen energy EDPn that is lost through purging, ΔEDPn, and purging interval, tn."

(4) "[O]ne skilled in the art would not be able to calculate the first energy loss and the second energy loss without additional guidance on how to determine the maps shown in Figures 6 and 7."

Applicant respectfully asserts that the as-filed specification provides enabling support for a person of ordinary skill in the art to make and use the claimed invention. Initially, the present specification at page 9, lines 12-24, teaches that the nitrogen partial pressure PNn of an anode gas is calculated by first determining an amount of permeated nitrogen gas using equations (1) and (2) which are reproduced below.

(1) ***Amount of permeated nitrogen gas =***
K · (membrane area / membrane thickness) · (nitrogen partial pressure difference between anode gas and cathode gas) · Δt;
where K = gas permeation coefficient of the electrolyte membrane during an operation

(2) ***Overall permeated nitrogen gas amount =***
$\int$(permeated nitrogen gas amount) ∞ $\int$(nitrogen gas partial pressure difference between anode and cathode) · Δt

Equation (1) is used to determine the amount of nitrogen gas permeating an electrolyte membrane from the cathode to the anode of the fuel cell stack from a time tn_{-1} to the time tn, whereby the membrane area and the membrane thickness of the electrolyte membrane are known fixed values. The specification at page 10, lines 1-6 clearly states that it can be proven via experimentation, simulation or calculations based on the characteristics of the electrolyte membrane, when the fuel cell stack is operated in a steady state, the nitrogen partial pressure PNn of the cathode gas is substantially constant while the nitrogen partial pressure PNn of the anode gas gradually increases over time due to the nitrogen gas which permeates through the electrolyte membrane. Equation (2) is used to determine the value of the permeated nitrogen gas amount of equation 1 integrated over the time period t0 to tn.

Specifically, the present specification at page 10, line 21 through page 11, line 3 teaches that the nitrogen partial pressure PNn of the anode gas is calculated by equation (3) which is reproduced below.

(3) ***PNn =***

((anode gas pressure) · (normal – pressure volume of nitrogen in passage)) / ((passage volume) · (anode gas pressure)) / (normal pressure)

The specification further teaches that the normal-pressure volume of the nitrogen in the passage is calculated from the overall permeated nitrogen gas amount obtained in equation (2); the passage volume is the volume of the re-circulation passage from the anode through the return passage and part of the hydrogen supply passage an back to the anode; the normal pressure and volume of the passage are known values; and the anode gas pressure cancels out from the equation (Page 11, lines 5-11). It should be noted that the nitrogen partial pressure PNn of the anode gas can be calculated from the calculation result of equation (2) (Page 11 lines 12 and 13).

The present specification at page 11, line 21 through page 12, line 1 further teaches that the hydrogen partial pressure PH2n of anode gas is calculated from the nitrogen partial pressure PNn and the water vapor partial pressure PWSn using the equation (4) which is reproduced below.

(4) ***PH2n = (anode gas pressure) – (PNn + PWSn)***

A qualitative value for the water vapor partial pressure PWSn is obtained using the graph of Figure 5. As illustrated, the curve of the graph represents the comparison of the temperature of the fuel stack TCSAn, (plotted on the abscissa), with the water vapor partial pressure PWSn (plotted on the ordinance). Initially, the pressure remains constant as the temperature increases. Afterwards the pressure linearly increases as the temperature increases.

The present specification at page 12, lines 4-10 also teaches that the generated energy EDH2n of the fuel cell stack 1 is equivalent to the output power of the fuel cell stack 1. A qualitative value for the generated energy EDH2n is obtained using the graph of Figure 6. As illustrated, the curve of the graph represents the comparison of nitrogen partial pressure PNn (calculated from equation 3) (plotted on the abscissa), with the generated energy EDH2n (plotted on the ordinance). Initially, the generated energy remains constant as the nitrogen partial pressure increases. Afterwards, the generated energy linearly increases as the nitrogen

partial pressure increases. Finally, the generated energy exponentially increases as the nitrogen partial pressure increases.

The present specification at page 12, lines 16-20 further teaches that a variation in the hydrogen energy ΔEDPn of the fuel cell stack 1 is equivalent to the claimed second energy loss. A qualitative value for the variation in the hydrogen energy ΔEDPn is obtained using the graph of Figure 7. As illustrated, the curve of the graph represents the comparison of elapsed time (plotted on the abscissa), with the variation in the hydrogen energy ΔEDPn (plotted on the ordinance). Initially, the variation in the hydrogen energy ΔEDPn decreases as the elapsed time increases. Afterwards, the variation in the hydrogen energy ΔEDPn remains constant as the elapsed time increases.

PTO's First Allegation

Regarding the PTO's first allegation that there is no explanation on how the map of Figure 6 is generated and that there are no units provided for the generated energy EDH2n or the hydrogen partial pressure PH2n, Applicant respectfully submits that the map of Figure 6 can be easily generated using equations (1)-(4) discussed above with the fuel cell stack illustrated in Figure 1. As discussed above, the hydrogen partial pressure PH2n is calculated using equation (4).

Equation (4) includes the overall permeated nitrogen gas amount of the fuel cell stack parameter which is calculated from equations (1) and (2) and includes known values such as the membrane area, membrane thickness and gas permeation coefficient of the electrolyte member of the fuel cell stack, the nitrogen partial pressure of the cathode gas parameter which is substantially constant when the fuel cell stack is operated in a steady state, and the nitrogen partial pressure of the anode gas parameter which is calculated to increase over time.

Equation (4) also includes parameters such as the passage volume and normal pressure of the fuel cell stack which have known values; the temperature TCSAn of the fuel cell stack detected by a temperature sensor; and the water vapor partial pressure PWSn determined from the temperature TCSAn. Values for these variables are calculated from a time t0 to tn, for example. The generated energy EDH2n, of the fuel cell is equivalent to the output energy of the fuel cell stack and hence this value can be measured. For example, the generated energy EDH2n could be measured in a state where no purging is performed. The

hydrogen partial pressure PH2n of the anode gas at the time of this measurement can be calculated from the measurement conditions. By plotting the pairs of EDH2n and PH2n, which show time-dependent variations, on a graph, a usable map corresponding to Figure 6 is easily obtained.

Regarding the units, any units can be assigned to these parameters as long as the units have a fixed relation to standard units. For example, the generated energy can be expressed in joules (J) since the variable EDH2n represents energy. Likewise, the hydrogen partial pressure can be expressed in newton per square meter (N/m^2) since the variable PH2n represents pressure.

PTO's Second Allegation

Regarding the PTO's second allegation that there is no explanation on what variables are measured, what mathematical formula or equation is used to calculate the generated energy EDH2n, the fuel cell operating conditions that were used to generate the map, or the hydrogen partial pressure PH2n shown in Figure 6, Applicant respectfully submits that the hydrogen partial pressure PH2n is calculated using equation (4) as discussed above. When the fuel cell stack is operated in a steady state, the anode gas pressure of equation (4) is a constant known value. The nitrogen partial pressure PNn of equation (4) is calculated based on equation (3) with each of the variables of equation (3) defined as discussed above. Also as discussed above, a value for the water vapor partial pressure PWSn of equation (4) can be obtained using the graph of Figure 5, whereby the curve of the graph represents the comparison of the temperature of the fuel stack TCSAn, (plotted on the abscissa), with the water vapor partial pressure PWSn (plotted on the ordinance). Initially, the pressure remains constant as the temperature increases. Afterwards the pressure linearly increases as the temperature increases.

PTO's Third Allegation

Regarding the PTO's third allegation that there is no explanation for the calculation of the second energy loss based on the map shown in Figure 7, Applicant respectfully submits that the hydrogen energy EDPn is based on the purging interval of the fuel cell. A preferred purging point A (defined during the time period between t0 and tn) shown in Figure 3, provides that the sum of energy loss due to not purging and the energy loss due to purging

takes a minimum value (specification, page 8, lines 12-14). A qualitative value for the variation in the hydrogen energy ΔEDPn can be obtained whereby the curve of the graph of Figure 7 represents the comparison of the elapsed time since purging (plotted on the abscissa), with the variation in the hydrogen energy ΔEDPn (plotted on the ordinance). Initially, the variation in the hydrogen energy ΔEDPn decreases as the elapsed time increases. Afterwards, the variation in the hydrogen energy ΔEDPn remains constant as the elapsed time increases. Thus, the map of Figure 7 can be easily obtained by measuring the generated energy in a state where purging is performed.

PTO's Fourth Allegation

Regarding the PTO's fourth allegation that one skilled in the art would not be able to calculate the first energy loss and the second energy loss without additional guidance on how to determine the maps shown in Figures 6 and 7, Applicant respectfully submits that maps of Figures 6 and 7 can be easily generated based on the equations discussed above and due to routine experimentation using the fuel cell stack illustrated in Figure 1.

Accordingly, the as-filed application provides sufficient disclosure to guide one of ordinary skill in the art to practice the invention as claimed.

(4-5) The Breadth of the Claims and Quantity of Experimentation

The PTO alleges "one skilled in the art would not be able to make and use the claimed invention without undue experimentation...[and]...[w]ithout knowing the specifics on how to generate the maps shown in Figures 6 and 7, one skilled in the art would require a considerable amount of experimentation that is not routine in the art." *See* Office Action, page 4.

Applicant asserts that the as-filed specification provides full disclosure for one of ordinary skill in the art to generate the maps of Figures 6 and 7. In particular, the specification discloses an anode effluent control method for a fuel cell power plant including calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed and calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened. These calculations are based on the maps of Figures 6 and 7, respectively. While

Applicant concedes that each of the maps of Figures 6 and 7 specifies the relationship between two parameters qualitatively and not quantitatively, one of ordinary skill in the art can generate a map through routine experimentation if provided with qualitative or relational information (e.g., the shape of a curve) between two parameters as shown in Figures 6 and 7.

For example, one of skill in the art can generate an approximation formula such as $y = Ax^2 + Bx + C$ from a shape of a curve showing a qualitative relation between two parameters x, y. By obtaining a couple of experimental results (xi, yi), one can determine the coefficients A, B, C. Such an approximation process is well known in the art.

The as-filed specification on page 9, line 12 through page 12, line 1 clearly provides equations (1)-(4) which are used to calculate values for some of the parameters compared on the maps. Figures 6 and 7 include curves (i.e., known linear and exponential curves) representing the comparison of these parameters and showing a qualitative relationship between these parameters. The specification also provides details on how to determine unknown parameter by performing simple experiments using the fuel cell stack illustrated in Figure 1 and described at page 5, line 16 through page 7, line 15. Thus, a skilled artisan would be able to generate the maps of Figures 6 and 7 with ease given this information.

The fact that some experimentation may be necessary to make or use the invention does not render the specification non-enabling. It is well established that "an extended period of experimentation may not be undue if the skilled artisan is provided sufficient direction or guidance." *In re Colianni*, 561 F.2d 220, 224, 195 USPQ 150, 153 (CCPA 1977). Moreover, it has been argued that "...a considerable amount of experimentation is permissible, if it is merely routine, or if the specification in question provides a reasonable amount of guidance with respect to the direction in which the experimentation should proceed." *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed Cir. 1988). Applicant asserts that the present specification has provided a reasonable amount of guidance on how to generate the maps of Figures 6 and 7 and that the generation of maps such as these are not only well-known, but routine, to one of skill in the art. Thus, the enablement rejection of claims 25-49 is improper, and should be withdrawn.

CONCLUSION

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing or a credit card payment form being unsigned, providing incorrect information resulting in a rejected credit card transaction, or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

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